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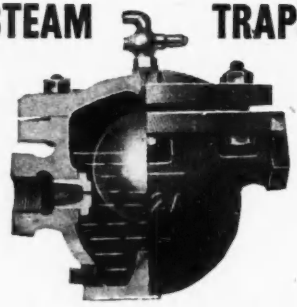

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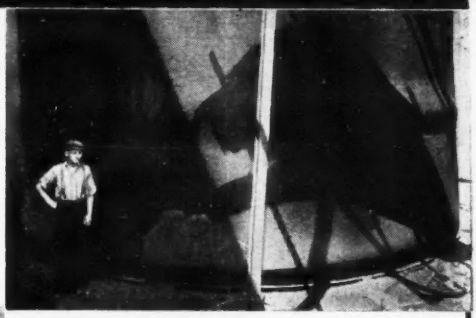

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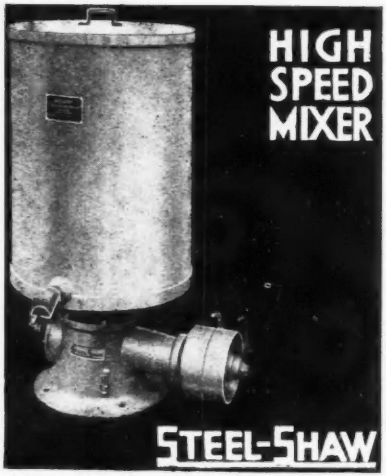

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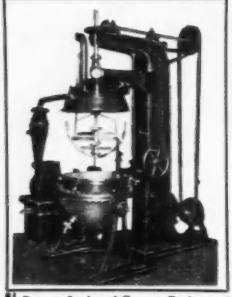

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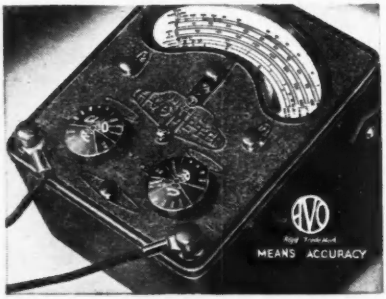

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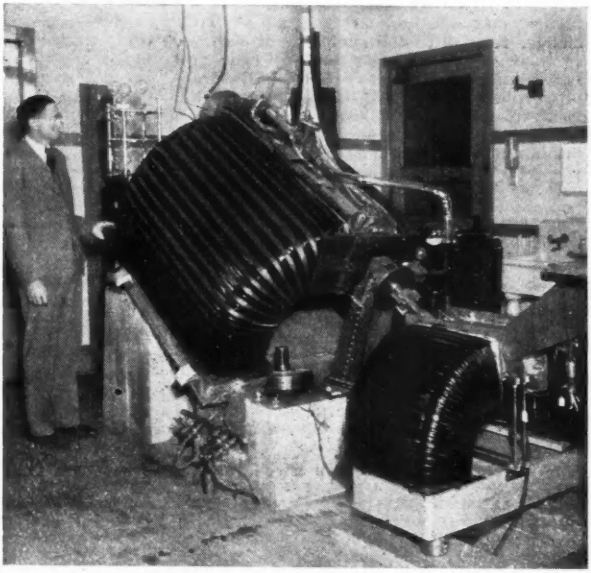
The Mass Spectrograph

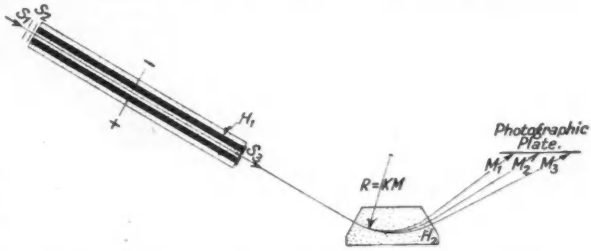
Measurement of Atomic Mass and Energy

NEW standards in the measurement of atoms, "the building blocks of the universe," are being set by a machine, the mass spectrograph, which, in effect, "weighs" atoms. Only five devices of the kind are operating in the world, and the example at the University of Illinois, here described, is six times as powerful as any other. Possibilities and accuracy are in proportion to the power. Dr. E. B. Jordan, Professor of Physics, designed and built the machine. Problems for investigation which he already foresees will take more than a lifetime to study.

The mass spectrograph consists essentially of two parts; an analyser and a dispenser. Atoms, the masses of which are to be measured, are introduced in gaseous form into a discharge tube (H_1). There, by means of an electric current passed through the gas, one or more electrons are removed and the stripped atoms, no longer being electrically neutral, can now be influenced by electric and magnetic fields. They have a handle, so to speak. Owing to the presence of electrical fields within the discharge, the stripped atoms, or ions, are forced to move along the axis of the tube towards the anode and thence through two narrow collimating slits (0.0015 in. wide and 1.25 in. apart) into the analyser.



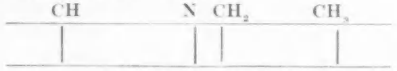
Above: Professor Jordan with the mass spectrograph.
Below: Diagrammatic lay-out of the apparatus.



Any charged particle or ion entering the analyser is subjected to two forces, both of which are perpendicular to its direction of motion. One force, due to an electrical field, is directly proportional to the charge carried by the ion. The other force, working in a direction opposite to the first, is due to the presence of a magnetic field. This latter force is proportional to *both* the velocity and the charge associated with the ion. Thus, for one particular velocity, these two forces balance each other exactly and the path of the charged particle will be a straight line. A slit, placed at the far end of the analyser, thus serves to cut out all ions except those which have the critical velocity and which consequently are not deflected in passing through the analyser. Ions having a velocity greater or smaller than

the critical are deflected to one side. Since neither force depends upon the mass of the particle involved, ions having totally different masses but travelling at the same critical speed will get through. In this way, the velocity variable is eliminated.

After leaving the analyser the ions enter the second section of the spectrograph, which, for convenience, may be called the disperser (H_2). The disperser consists of a uniform magnetic field arranged in a special manner relative to the analyser. It serves two purposes: (a) It deflects any one ion in a circular arc with a radius of curvature proportional to the ion's mass. Thus the mono-velocity but multi-mass ion beam which enters the disperser is now broken up into a number of beams (M_1, M_2, M_3), each one of which is characterised by a given mass. (b) These separate beams are brought to a very fine focus at different positions on a photographic plate. (If the beam were not first sorted out by the analyser, only a smear many centimetres wide would be obtained on the plate.) From the positions of the lines on the photographic plate, it is possible to determine the masses of the corresponding stripped atoms relative to each other. In making the actual measurements, a precision method, commonly called the doublet method, is used. For example, to find the mass of the nitrogen atom relative to that of carbon, a mixture of gases containing these atoms would be allowed to enter the discharge tube. The resulting trace which would be obtained on the photographic plate is indicated schematically below.



By comparing the distance between the doublet lines, *i.e.*, the N and CH_2 lines, and the far lines on either side, the mass difference between the nitrogen atom and the CH_2 molecule is obtained. In a similar manner, the mass of carbon and of hydrogen can be obtained relative to oxygen, the standard, and thus the mass of nitrogen relative to oxygen can be computed.

The following are points of particular interest: (1) When properly focussed, the line breadths obtained on the photographic plate are only 0.0045 cm. wide (actual measurement). This represents a very high degree of focussing accuracy, since at some points along its path each separate ion beam is 0.3 cm. wide. The action of the instrument is much more complicated than the simple theory would indicate. In order to gain intensity, not just a line beam, but a beam several millimetres wide is allowed to leave the analyser. This introduces both a velocity spread and a spread in angles within the beam. On entering the disperser, this complicated beam is not only broken up into its many constituent parts, but each of these separate beams is in turn brought to a very narrow focus. This focussing also corrects for several different kinds of aberrations. Aberrations occur in this type of work just as in the case of light lenses, but are more difficult to handle because one is dealing with charged particles having very little inertia. Actual masses are of the order of magnitude of 10^{-22} to 10^{-23} gm.

(2) If, during the time that an exposure is made, one of the magnetic fields should vary by as much as one part in 1500, the line breadth would be increased by a factor of 60. (3) Atomic masses of the light elements can be obtained to an accuracy of approximately one part in a million. This does not necessarily mean that mass differences as ordinarily published are as accurate as this. (4) To illustrate the actual separating power of the instrument the following example is given: The hydrogen-deuterium doublet lines, *i.e.*, the lines corresponding to the hydrogen molecule H_2 and the deuterium atom D, are separated a distance of 1.1 mm. These two particles differ in mass by only 2.5×10^{-27} grams.

(5) The magnet which supplies the analyser magnetic field weighs 6.8 tons. The disperser magnetic field is supplied by a second magnet that weighs 1.5 tons. (6) All parts are machined to an accuracy of one-thousandth of an inch. (7) The over-all alignment of the different parts of the instrument was accomplished by triangulation. (8) The path length through which the atomic particles travel from source to photographic plate is 2.9 metres.

Some Dimensions

Professor Jordan spent six months designing the mass spectrograph, and two years in building it. Two large electromagnets form its greatest bulk. The designer wound these by hand, using 2600 pounds of copper wire. The larger magnet has a 5½-ton core of special iron. Five thousand turns of wire are wound on it. The smaller magnet has a 1½-ton iron core with 3000 turns of wire. Each magnet is a single casting. The pole faces had to be ground to be accurately parallel within .001 inch. The machine is supported on a vibration-proof concrete pier system weighing 32 tons. A vacuum tube 114 inches long provides the path through which atoms pass. Special "Q" emulsion photographic plates, 16 in. long by 2 in. wide, are used in the mass spectrograph, and ten parallel exposures are made on each. The plates, of which Professor Jordan has stored up a two-year supply, are manufactured in England. Professor Jordan's mass spectrograph is claimed to provide narrower lines and greater separation of them than any other device, resulting in more accurate recording of atomic weight than has hitherto been possible.

South African Chemical Progress

Leather Research Aids Chemical Industry

WORK of the South African Leather Industries Research Institute, Rhodes University College, though primarily directed towards the development of the leather industries, promises to lead to much wider development in the South African chemical industry, especially important in war time, with great post-war possibilities. Dr. S. G. Shuttleworth, A.I.C., director of the Institute, has outlined its work in the official *Journal of the Department of Commerce and Industries* (July, 1942), some extracts from which are given here. The record is especially remarkable, in that the Research Institute has just completed its first year of operation, and is only now becoming adequately housed, staffed, and equipped.

Tanning Salts

For the production of chrome leather, for example, it is necessary that the tanneries be assured of supplies of chrome tanning salts. The writer anticipated the probability of a shortage of chrome tanning supplies in June last year, and drew the attention of various interested bodies to the fact that chrome ore was being shipped to America from South Africa, converted to chrome tanning salts, and returned to South Africa. The Research Institute developed a process, based on the conversion of crude ferro-chrome ore to chrome tanning salts by a direct method. However, at that time the steel mills were not producing sufficient ferro-chrome ore, and as a result the oxidation reduction process was installed instead of the direct conversion method. At present the Marble Lime Company, assisted by the Industrial Development Corporation and by War Supplies, are producing approximately sufficient chrome tanning salts to meet South African requirements. At the same time the Research Institute has been investigating the sulphonation of South African whale and fish oils to replace imported sulphonated cod oil. On February 27 this year the writer had the privilege of setting in motion the General Chemical Corporation's sulphonated whale oil plant, capable of producing well over 1000 tons per annum of a product fully equal to the imported, and using a process which should be economically competitive after the war. Research is also being carried out on the production of sulphonated seal oil and on the utilisation of other fish oils. Another local source of leather lubricants is the waste wool grease of the wool-washeries, and it is hoped to incorporate this in fat liquors for the leather trade.

When visiting industrial undertakings in America, the writer became interested in the founding of a South African glue and gelatin industry, utilising the waste products of the South African tanneries. The most suitable process involves washing the tannery fleshings and limings, dissolving in hot water, evaporating under reduced pressure, pouring into moulds to set, cutting into thin slabs and drying. With the technical co-operation and advice from the Institute, the methods outlined were put into large-scale operation at Port Elizabeth by the United Soap Works, who are now producing a good furniture glue with extremely satisfactory adhesive properties. They are able to absorb the waste fleshings and limings of the tanneries, and with the introduction of bleaching and centrifuging may well develop gelatin production in the future. The fleshing greases which are a by-product are being utilised in soap manufacture. Sutherlands Tannery has also been interested in glue manufacture, and is contemplating large-scale production at Pietermaritzburg.

Adhesives, Lacquers and Finishes

Cellulose adhesives are made by removing the gelatin from scrap cinema film by means of warm caustic soda solution, and dissolving the washed film in acetone. As acetone is urgently required for explosive production, the Research Institute has developed a substitute which can be produced locally. The General Chemical Corporation are now manufacturing cellulose adhesives according to the methods outlined by the Institute. They are also interesting themselves in the large-scale production of cellulose lacquers. These are essentially similar to cellulose adhesives, except that they are used in dilute form and also that careful attention has to be given to the use of solvents with the correct speed of drying and the incorporation of plasticisers, so that the lacquer film may be clear in appearance and may possess the properties of hardness or pliability according to the surface on which it is sprayed. Chrome Chemicals, Ltd., have also interested themselves in this branch of the Institute's research and are starting manufacture of cellulose lacquers and water pigment finishes.

One of the outstanding discoveries of the Research Institute during its short period of existence is the plastic L.I.R.I. 568, which, dissolved in a suitable solvent, has the valuable property of binding and firming fibrous material such as leather or felt. At first the production of this plastic was carried out at the Institute, but demands became so great that arrangements were made for large-scale production by Patlansky Bros. & Schauder, Port Elizabeth, who

have installed a plant for the purpose. In the production of the lighter types of leather an essential process is the action of proteolytic enzymes on the hide or skin after removal of the hair, in order to open up the fibre structure and to remove degraded keratin and elastin tissue from the surface. This process is known as bating, and modern bating materials are manufactured from the pancreatic glands of pigs. Enzymes from fruit, such as pineapple waste from the canning factories were found unsatisfactory, as they were self-digesting and lost their action on storage. A second research carried out, using waste fish viscera, met with complete success, both for satisfactory keeping properties and in superiority to the imported article in large-scale practical application. The bating power was found to be adequate, but whereas the fish viscera bate functions best at room temperature, the imported bate, manufactured from animal glands, requires an elevated temperature for optimum action. Messrs. Irvin & Johnston are planning large-scale producion of fish bate.

Wax from Bagasse

Experiments on the utilisation of sugar-cane wax in the leather industries are being conducted by the Institute, and personal contact has been made by the writer with Natal Cane By-Products, Ltd., with a view to the recovery of this wax from bagasse, which contains from 5 to 10 per cent. of wax, depending on the process of sugar extraction.

Research on the production of lactic acid by fermentation of whey revealed that by the text-book process the fermentation slowed down and gradually ceased before 50 per cent. of the sugar had been converted. The Institute has discovered that the lime added to prevent increase of acid to a quantity too great for fermentation precipitates the phosphate, and the absence of phosphate necessary to the health and vitality of the bacteria causes the fermentation to slow down and cease. Addition of complex phosphates not precipitated by calcium has solved the problem, and negotiations are now under way for the South African production of lactic acid.

On behalf of the South African wattle growers, the Institute is undertaking research in the field of specialised tanning extracts, and has already met with some success in the production of a bleached wattle extract for the production of light-coloured leathers. Arrangements are being made for the production of this bleached extract in South Africa.

The process for the production of sodium sulphide consists essentially of roasting sodium sulphate in the presence of an excess of carbon which reduces the sulphate to the sulphide. This manufacture is being undertaken by Sodium Chemicals, Ltd., at the suggestion of the Institute, which is co-operating with technical advice. It is hoped that initial production difficulties will be smoothed out and that sodium sulphide equal to the imported product will be turned out sufficient to supply South African tanning requirements.

Phosphate Deposits

The development of fertilisers, notably phosphate rock, has been examined by Mr. O. H. Parry, A.C.I.S., in the *South African Mining and Engineering Review*. There are, he says, three main deposits of phosphate rock in the Union, economical exploitation of which seem possible. Each varies in chemical composition, and presents different problems as regards its availability as phosphatic plant food. The Palabora deposit in Northern Transvaal contains apatite in considerable quantities, while the Saldanha Bay deposits, north of Cape Town, are estimated to contain several hundred thousand tons of phosphate rock, with a phosphate content varying from 15 to 25 per cent. It occurs in a combination of alumina and iron. One of these deposits, however, is of calcium phosphate, and although it is of low grade it is easier to treat than the others and is expected to be exploited shortly.

Potassic Fertilisers

The possibility of producing greater quantities of potassium for fertilisers, the need for which grows with the increase in feedstuff production, is also under consideration. It is hoped that a process may be evolved whereby the large occurrences of potassium feldspars found in granite and similar rocks in the Union can be used. Orthoclase and microcline ($K_2O.Al_2O_3.6SiO_2$) occur as essential constituents in the more igneous rocks (granite, syenite, pegmatites, etc.) in varying quantities around 40 per cent., and it is calculated that from one short ton of granite c. 800 lb. of potash feldspar could be extracted. This in its turn could yield 147 lb. of aluminium oxide and 135 lb. of potassium oxide. It should be possible to separate the feldspar from the other constituents by a flotation process, and then to treat the feldspar so that the potassium could be separated from the silica and alumina. The 18.4 per cent. alumina content could be used in industry, while the potassium would also form the basis for potassium chloride (used in the manufacture of cheddite and of matches), and for potassic nitrate (saltpetre, manufactured from potassium chloride and synthetic HNO_3), as well as fertilisers. Although no experiments have as yet been carried out in this direction, the possibilities are obvious and research should not be delayed.

Many Industries Seek a Plan

Post-War Reconstruction in Trade Discussions

THE recent publication of the report of the Committee on Land Utilisation in Rural Areas has been followed by a spate of discussion on the subject of industrial planning on which the committee dwelt at some length. Mr. G. E. Hardy, Oldham's borough engineer and surveyor, points out that England, with a population of 766 per square mile, is the most densely populated country in the world, and he advocates national control of the location of industry. He believes that decentralisation and ultimate reconstruction of the large centres is the solution to the problems resulting from the disorderly and sporadic growth of our towns. His anxiety that the pre-war drift of industry to the Midland and the South may be resumed will be understood.

Dr. Dudley Stamp, who has been appointed adviser on rural land utilisation to the Minister of Agriculture, seems to agree that an organisation ready to advise on planning schemes is necessary. His chief concern, however, is to safeguard fertile land for agriculture. A large amount of decentralisation of industry has taken place as a result of the war. Many of the armament factories will close down after their purpose has been served; new peace-time industries will be set up and the existing factories may serve, if some effort is made to sort them out, to house them. Much help could be given in this respect by a clearing-house which would see that the best use was made of existing plants and buildings before new concentrations of factories were allowed to spring up.

The tendency at the present time seems to be for individual industries to do their own planning. One of the most outstanding developments in the chemical industry in recent months has been the working towards closer co-operation. The establishment of a Conjoint Chemical Office is an example of this tendency. It is part of the very nature of the chemical industry to be international. The *Manchester Guardian* recently voiced its concern at the growth of industries in overseas countries which used to import the goods they now make for themselves as a result of the war. It mentioned particularly the engineering and chemical industries which have, undoubtedly, expanded rapidly in many parts of the world. Australia, Canada, and India will come out of the war with thriving chemical industries. Many other countries which have relied on outside help are fast becoming independent of imported supplies. But is this in itself a bad thing? Is it not reasonable to believe that if, as seems certain, the competition motif is to be played down, and planning for mutual benefit is to take a more prominent place in world affairs, the consequences of industrial development overseas will not be as serious as it appears at first examination? There will be much need for reconstruction after the war and supplies of all kinds of useful goods should meet with a ready demand. In a properly planned economy the question of shortage of markets will not arise.

It is refreshing to find that in at least one industry a kind word has been said for new developments which have, in the past, been thought to threaten the older trade. At the opening of the winter session of the Yorkshire section of the Textile Institute in Bradford questions concerning synthetic fibres were put to a "brains trust." One of these questions was: Can the wool textile trade afford to adopt a complacent attitude towards synthetic fibres, in view of the world development of these fibres for use in conjunction with wool? Mr. W. Hunter replied to the effect that he did not fear that the competition of synthetic fibres was going to interfere seriously with the current and accumulated wool stocks which would exist at the end of the war. It might be, he said, for that reason that those engaged in wool production and consumption were not unduly pessimistic regarding the future. Dr. L. L. Lloyd, representing the dyeing section, added that he thought synthetic fibres should be used to the maximum extent in enhancing the value of wool, while Mr. E. J. Poole believed that the use and application of the attributes of synthetic fibres were bound to increase the consumption of wool.

Neither does this question of the tremendous development of synthetic materials seem to be worrying the cotton interests unduly. At the opening of a recent exhibition, Mr. Andrew Naesmith, general secretary of the Weavers' Amalgamation, said that people with a life's experience of the industry were astonished at the variety of uses to which textile products were being put to-day. The sympathy of the Government would be needed, he said, in formulating international trade treaties. Surely no one could doubt that the order of unbridled competition had changed. He believed that planned production would be essential.

The story is the same to whatever industry one turns. A public utility body such as the gas industry talks, as it has done at recent conferences, of the march of plan-

ning hand in hand with post-war reconstruction. This is not a purely domestic affair, of course, for to an ever greater extent the chemical industry is involved therein through the by-products of coal, while nearly every other trade is affected by its requirements of the industry's fuel products. Welsh tinplate interests, too, have raised their voice on a similar note.

These instances of efforts at organisation for the purpose of planning could be multiplied. Some may be taken as evidence of anxiety: nobody wants to be squeezed out after the war. But in the main there is a desire to get together for the construction in unison of a better system of distribution than before. If this desire can convey itself effectively to those into whose hands post-war reconstruction will ultimately fall, the apparently inconclusive discussions that are now going on will have served their purpose.

Personal Notes

SIR J. DONALD POLLOCK, chairman of Metal Industries, Ltd., has been re-elected Lord Rector of Edinburgh University.

MR. J. E. WAKEFORD, M.B.E., F.C.S., M.Inst.Gas E., has been appointed engineer and manager of the Warrington gas undertaking.

MR. ERNEST WATKINSON, a director of Boots Cash Chemists (Eastern), Ltd., was married last week at Huntingdon to Miss Nina Llewela Jones.

MR. S. H. BEAN (Charles Wiggins & Co., Ltd., London) has been elected president of the National Lubricating Oil and Grease Federation, and MR. V. H. SCOTT (Matthew Wells & Co., Ltd., Manchester) vice-president.

DR. S. WERNICK and MR. E. A. OLLARD have been appointed to act as members of a special committee set up by the Ministry of Aircraft Production (Directorate of Technical Development) and the Electrodepositors' Technical Society to investigate specifications and technical problems relating to electrodeposition.

MAJOR ALAN MONCRIEFF, O.B.E., M.C., has taken up the post of general manager of the ironworks branch of Coal Distillation, Ltd., which is a subsidiary of Newton Chambers and Co., Ltd. He succeeds Major W. T. Kitching, who is now chief engineer of the Appleby-Frodingham Works of the United Steel Companies, Ltd.

Chemical science is well recognised in the recent list of awards of the Royal Society. One of the Royal Medals for the current year has, with the King's approval, been awarded to PROFESSOR W. N. HAWORTH, F.R.S., for his contributions to organic chemistry, particularly on the constitution of the sugars and the structure of complex polysaccharides. The Copley Medal goes to SIR ROBERT ROBINSON, F.R.S., for research work of outstanding brilliance which has embraced the whole field of organic chemistry; and the Davy Medal is awarded to PROFESSOR C. N. HINSHELWOOD, F.R.S., for distinguished work on the mechanism of chemical reactions.

Obituary

MR. GUY STEPHENSON, manager for 20 years of Pease and Partners' coke and by-product works at Bankfoot, Crook (Co. Durham), has died at Crook. He was formerly chief chemist in the firm's West Laboratory.

New Control Orders

Bauxite and Cryolite Imports

With effect from November 9, the Board of Trade has revoked the Open General Licence permitting the importation without separate licence of bauxite and cryolite, natural and synthetic. On and after that date separate licences will be required, except in the case of goods despatched to the United Kingdom before November 9 and imported into the United Kingdom before January 9, 1943. Applications for licences should be sent to the Import Licensing Department.

Waste and Reclaimed Rubber

By the Control of Rubber (No. 18) Order (S. R. & O. 1942, No. 2234; price 2d.), which came into force on November 5, the acquisition of waste and reclaimed rubber is made subject to licence, and disposal of these materials is permitted only to persons who hold licences to acquire them. These restrictions do not, however, apply to collections of waste rubber for the purposes of any salvage scheme, nor to purchases of waste rubber by Certified Waste Rubber Merchants or other persons who deal in waste rubber. The use of waste and reclaimed rubber is also made subject to licence, and there is a specific prohibition on burning or destroying waste rubber. Applications for licences to acquire or use waste or reclaimed rubber should be made to Rubber Control, Empire House, St. Martin's-le-Grand, London, E.C.1. The Order fixes maximum prices for waste and reclaimed rubber, and limits the amounts which may be charged for reclaiming waste rubber. A uniform maximum price for each type of waste rubber will now govern all transactions. All persons who have in their possession more than 5 cwt. of waste rubber must declare in writing to the Rubber Control within 21 days the approximate weight of their stock, and the premises where it is situated. This declaration is not required from persons who are already making a regular return of their waste rubber stocks.

General News——From Week to Week

A sum of £3016 has been raised in three months by a Coventry factory to purchase two X-ray mobile units for the Russian Army.

Experiments made by Wallasey Corporation Motor Bus Department with liquid fuel made from town gas have been so successful that it has been decided to change over the entire bus fleet to this fuel.

All connected with the manufacture of nickel and its by-products would be far more prosperous in peace than in war, said Mr. D. Owen Evans, M.P., for Cardiganshire and vice-president and director of the Mond Nickel Company, in a recent speech.

In a paper on vitamin-C nutrition, Dr. Geraldine MacNee and Dr. James Reid, of the University of Glasgow, state: "Our results seem to show that in adults, both in the Royal Navy and among civilian workers, the levels of vitamin-C nutrition are adequate for good health."

The value of chemicals used in the paper-making industry in Eire last year showed a slight decline—from £17,286 in 1940 to £17,140 in 1941—according to a Census of Industrial Production Report covering the paper industry, recently issued by the Department of Industry and Commerce in Dublin.

Containers of specially treated cardboard made from waste paper are now being used to carry petrol to our tanks and planes. It has been found that cardboard makes safer containers than tin in some instances as, being an insulated material, it is a protection against the danger of contact with electrical currents. Another reason for saving waste paper.

Scottish firms are opposing the Government scheme for the concentration of the paint industry. They claim that not more than 800 workers who could be otherwise employed will be released by the scheme, and also say that it is unjust in that it favours a selected minority to the detriment of others. It is understood that the Government is prepared to consider criticism not affecting the scheme's main structure.

The future of the British chemical industry was the subject of an address by Dr. Sarsfield to the Widnes Labour Party last week. He deprecated the view that Britain should be treated as an economic unit to be bettered at the expense of others, and also that industry should be controlled by the people who now controlled it. Pleading for control by the workers, he declared that unless the workers virtually took control in Parliament and in Government there could be no future for the British chemical industry.

Messrs. R. W. Greeff and Co., Ltd., announce that, from November 16, the branches of their business operating from Cornwood, Little Hadham, will be transferred to The Retreat, Avenue Road, Bishop's Stortford, Herts. (Tel.: Bishop's Stortford 1140).

Problems and policies affecting the present and future of buildings and civil engineering in relation to the country's requirements are to be examined by an Advisory Council, representing the employer, operative, and professional sides of the industries, which has been appointed by the Minister of Works and Planning.

In answer to a question in the House of Commons, the Foreign Under-Secretary indicated that he was satisfied that the agreement for the international control of production and export of tin was within the letter and spirit of the Atlantic Charter. It was calculated, he said, to smooth out oscillations in price which were to the benefit neither of the consumers nor the producers.

Foreign News

Canadian mines produced 1,474,462 tons of coal in July, compared with 1,214,319 tons in July, 1941, and with the July average for 1937-1941 of 1,110,226 tons.

A new material has been developed by the Du Pont de Nemours Co. as a substitute for two important materials that normally come from the Far East—kapok and sponge rubber, says Reuter from New York.

Consumption of cadmium in the United States reached 8,063,000 lb. in 1941, a 31 per cent. increase over 1940. About 95 per cent. of the cadmium was consumed in electroplating, bearing alloys, and pigments.

Canada now produces over half the world's platinum, whose output totals annually between 600,000 and 700,000 oz. troy. The platinum is a by-product from the mining operations in copper and nickel in the area of Sudbury, Ontario.

Spanish zinc smelting capacity has been greatly extended. Real Compañia Asturiana del Minas has enlarged its plant at Arnao (Oviedo) where 18,000 tons of zinc can now be produced annually, including 3000 tons of 99.9 per cent. material. The zinc output is reported to leave a surplus for exports.

Plans for the immediate erection of a plant in the United States that will substantially increase supplies of ammonia and its derivatives have been announced by the Mathieson Alkali Works, Inc. It will be financed by the Defence Plant Corporation and operated by the company.

With the full approval of the Government of India, the recommendation of the American Technical Mission to India that a number of production engineers and technicians be sent from the U.S. to advise and assist in increasing Indian industrial production, has already been put in hand.

The huge quantities of reed and reed grass which grow wild in the Rumanian Danube delta will soon be used for cellulose production after the Italian model. The erection of one or more works for this production is planned by the Lelea and Zarnesti companies in conjunction with I.G. Farben A.-G.

A saving of 12,000 tons of copper has been effected during the past few months in the U.S. by the substitution of silver for copper in electrical conductors. A minimum of 34,000 tons of silver has been allocated for industrial purposes by the U.S. Treasury, and is to be returned to the Treasury after the war.

Elsässische Kaliwerke G.m.b.H., the company formed towards the end of last year by the state-owned Preussische Bergwerks-und Hütten-Gesellschaft to take over the administration of the potash mines in Alsace, has raised its capital from 50,000 to 15,000,000 marks.

The French chemical concern, S. A. pour l'Industrie Chimique, is reported to have changed its name to Chemische Werke Dornach G. m. b. H. Formerly connected with the Kuhlmann group and now under German control, this company makes dyestuffs, pharmaceutical products, etc.

A licence to manufacture linseed oil, meal, and cake has been granted to Dominion Industries, Ltd., Auckland. A factory to be erected at Dunedin will have an annual capacity of 1500 tons of oil and 3500 tons of meal plus cake. The intention is to provide a local outlet for New Zealand's flax-seed crop, which is increasing in importance.

The Swedish cellulose industry has been active in producing solvents to replace heavy naphtha. French turpentine, etc., which formerly covered about 80 per cent. of the country's requirements. Ethyl chloride is now extensively used in the bleaching trade, and a new group of solvents based on sulphite alcohol has been developed by Uddeholm and Mo & Domsjö. Methyl alcohol from wood is also increasingly employed.

Sir Clive Baillieu (British member) and Mr. William L. Batt (American member), of the Combined Raw Materials Board, have reported on their nine months' activities. On the Board's recommendation a joint mission was sent to the Belgian Congo by the United States and the United Kingdom to formulate a programme with the Belgian Government for increased production of tin, chromite, rubber and other strategic materials.

American scientists are experimenting with a machine for the X-ray examination of steel plates over eight inches thick. It has not, however, proved practicable yet. Its main feature is an electro-magnet weighing 125 tons composed of more than 100,000 parts of silicon steel.

Every farmer in Hungary, who deals with more than eight hectares, must now cultivate seven per cent. of the area with industrial plants, such as sunflowers, rape, linseed, soya beans, castor, or hemp. In return, he is entitled to a certain amount of artificial manure, and, after delivery of these products, to some of the extracted oil cake.

The Bauxit Trust A.-G., of Zürich, has establishd a Hungarian subsidiary, the Donautaler Tonerdeindustrie A.-G., to work a new factory for aluminium oxide in conjunction with an already existing plant. The capital of 35 million pengö is divided between the Hungarian State, the Zürich Company, and the Aluminium Werke A.-G., Berlin.

Canadian waterworks, according to a special report, used the following chemicals in 1941: 4764 tons of alum, 751 tons of chlorine, 2568 tons of lime, 500 tons of salt, 524 tons of soda ash, 105 tons of sulphur dioxide, 33 tons of chloride of lime, 33 tons of activated carbon, 66 tons of ammonium sulphate, and 4 tons of anhydrous ammonia.

Mines of the Geraldton district of Ontario, Canada, may play a part in supplying the Allied Nations with arsenic supplies which in peace time were obtained from Norway. The Hardrock Goldmines have shipped samples of the crude arsenic product to the U.S. Chemical Company and to a Canadian plant.

Indian roadside plants are providing valuable lubricants for war vehicles, thus helping to fill the gap left by destruction of the Burma wells. Most important is the castor oil plant. Experiments have been so successful that before long a large part of the defence service's needs may be met from this source.

The Slovakian cell-wool factory which cost 140 million Kr. to build is now in operation. Development work began in October, 1940, under patents from the I.G. Farbenindustrie which has financial control over the enterprise. The chemical materials required are supplied by the company's own factory at Novaky. The output is said to be in excess of Slovakian requirements.

The Montecatini combine is reported to have acquired a financial interest in the Amonal chemical factory in Bulgaria. Amonal has changed its name to Montecatini-Amonal and raised its capital to 3,000,000 leva. It will act mainly as a marketing organisation for Montecatini products in Bulgaria, but it is not impossible that the company will engage also in manufacture.

Forthcoming Events

A conference to discuss "The Chemist in Industry," arranged by the **Association of Scientific Workers** (London area; chemical industries sub-committee), will be held in the Caxton Hall, Westminster, S.W.1, on **November 15.** There will be two sessions, one at 11 a.m., and a second at 2.30 p.m.

There will be a meeting of the Plastics Group of the **Society of Chemical Industry** in the Chemical Society's rooms, Burlington House, W.1, at 2.30 p.m., on **November 17,** when an address on "Co-operation as a Post-War Problem" will be given by Mr. H. V. Potter. The Chemical Society, the Institute of Chemistry, the Chemical Engineering Group, and other bodies will also participate.

The 218th ordinary meeting of the **Society of Glass Technology** will be held at "Elmfield," Northumberland Road, Sheffield, on **November 18.** Two sessions will be held, the first at 11 a.m. and the second at 2 p.m. A series of papers will be read by Mr. T. H. Wang and Professor W. E. S. Turner, and the meeting will end with a symposium on "The Effect of Arsenic in Glass."

At a meeting of the Birmingham Section of the **Institute of Chemistry,** to be held in the Chamber of Commerce, Birmingham, at 5.30 p.m., on **November 18,** Dr. J. M. Webster will speak on "Forensic Science."

The annual general meeting of the London and South-Eastern Counties Section of the **Institute of Chemistry** will be held at 4 p.m., on **November 18,** at the Institute of Chemistry. An address on "Adulteration Past and Present" will be given by Dr. J. R. Nicholls, F.I.C.

The Sir William Bragg Memorial Lecture of the **Chemical Society** will take place in the lecture theatre of the Royal Institution, Albemarle Street, W.1, at 2.30 p.m., on **November 19,** when Professor J. D. Bernal will give some account of the life and work of Sir William Bragg.

A joint meeting of the Manchester Sections of the **Society of Chemical Industry** and the **Institution of the Rubber Industry** will take place at the Grand Hotel, Aytoun Street, Manchester, at 2 p.m., on **November 20,** when a paper entitled "Why is Rubber Elastic?" will be presented by Dr. L. R. G. Treloar.

A Cantor lecture of the **Royal Society of Arts** will be held at John Adam Street, Adelphi, W.C.2, at 1.45 p.m., on **November 23,** when Mr. A. C. Pallot, M.B.E., will speak on "Thermal Insulation at Medium Temperatures."

A meeting of the Midlands Section of the **Society of Glass Technology** will take place at 7.30 p.m., on **November 23,** at the Talbot Hotel, Stourbridge. Professor W. E. S. Turner will give an address on "Glasses for War-Time Purposes."

"Bread" is to be the title of the first of a series of lectures on "The History of our More Important Foods," which will be delivered to the **Royal Institution** by Mr. J. C. Drummond, D.Sc., F.I.C. There will be four lectures in all, and they will take place at the Royal Institution, Albemarle Street, W.1, at 3 p.m., every Tuesday, starting **November 24.**

A meeting of the **Institute of Fuel** will be held in the Connaught Rooms, Great Queen Street, W.2, at 2.30 p.m., on **November 26,** when Dr. D. H. Bangham and Dr. G. C. Phillpotts will present a paper on "The Standardisation of the Critical Air Blast Test."

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Company Winding-Up

CHEMICAL AND GENERAL DISTRIBUTORS, LTD. (C.W.U., 14/11/42.) Winding-up order, October 26.

Satisfaction

JOHN DALE, LTD. (formerly John Dale Metal Containers, Ltd.), London, E.C. (M.S. 14/11/42.) Satisfaction, October 9, £220, part of £700, registered April 12, 1937.

Company News

British Plaster Board, Ltd., have declared an interim dividend of 10 per cent. (same).

The Zinc Corporation has announced a net profit for 1941 of £139,200 (£148,442).

Metal Industries, Ltd., announce an interim dividend of 2½ per cent. (same).

Genatosan, Ltd., have announced a final dividend of 15 per cent., making 25 per cent. for the year (same).

The Paterson Engineering Co., Ltd., announce a profit of £53,480 (£31,853) for the year ended April 30.

Manbré and Garton, Ltd., have declared a final dividend of 12 per cent. on ordinary shares, making 17 per cent. (same).

New Companies Registered

M. E. K. Chemicals (Watford), Ltd. (377,004). — Private company. Capital: £100 in 100 shares of £1 each. Manufacturers of and dealers in chemicals, drugs, mericines, fertilisers, colours, oils, etc. Subscribers: A. E. West; A. E. H. Tench. First director: J. E. Clapham. Solicitors: Claude Barker and Partners, 153 The Parade, Watford.

Sterling Plastics, Ltd. (377,013).—Private company. Capital: £1000 in 1000 shares of £1 each. Manufacturers or wholesalers of moulded plastic articles. Subscribers: H. W. Fisher; Margaret E. Crichton. Registered office: 7 Oxford Circus Avenue, W.1.

Evans Residues, Ltd. (377,060).—Private company. Capital: £100 in 100 shares of £1 each. Manufacturing chemists, metallurgists, chemical engineers, metal workers, etc. Directors: T. G. C. Hendy; A. B. Bell; S. S. Lingford. Registered office: 3 Warwick Road, Boreham Wood, Herts.

MacLachlan, Clark and Co., Ltd. (22,210).—Registered in Edinburgh as a private company. Capital: £5000 in shares of £1 each. To acquire the business of manufacturing and analytical chemists carried on by MacLachlan, Clark and Co., 10 Lister Road, Hillington, Glasgow, S.W.2. Directors: G. A. C. MacLachlan, A. F. Rattray.

New Era Fertiliser Co., Ltd. (377,049).—Private company. Capital: £9000 in 9000 shares of £1 each. To acquire the business of manufacturers of organic fertilisers by a process developed and established by Crescens J. Allday and others, carried on at Weston Upper Mill, Oswestry, as the "New Era Fertiliser Co." Directors: C. J. Allday; Mrs. M. G. Bristow; A. E. Pearce; T. E. B. Pye. Solicitor: H. Bird Jones, Oswestry, Salop.

Chemical and Allied Stocks and Shares

ACTIVITY in Stock Exchange markets has shown further expansion under the influence of the war news. In some directions the rise was substantial on balance, although the upward trend of values induced a good deal of profit-taking, it being realised that yields are now very moderate, and that, owing to E.P.T., there will be very little scope for improved dividends during the war.

As was to be expected, shares of chemical and kindred companies reflected the prevailing trend. At the time of writing, Imperial Chemical have risen to 36s. 9d. which compares with 35s. 9d. a week ago, and the 7 per cent. preference units from 34s. 7½d. to 34s. 10½d. Lever & Unilever were 31s. 3d. compared with 30s., while Borax Consolidated rose to 34s. 9d., British Oxygen to 74s. 6d., and British Aluminium from 49s. 3d. to 50s. 3d. Elsewhere, Dunlop Rubber advanced to 35s., and the units of the Distillers Co. from 83s. 3d. to 84s. 9d., Babcock & Wilcox to 47s. 9d., and Turner & Newall to 76s. There were indications of speculative activity in some shares of companies which are generally believed to have little prospect of restoring dividend payments until after the war. Nevertheless, a good deal of buying appeared to be on the part of investors prepared to take a long view, it being realised that although the general trend of values may be upward, fluctuations must be expected from time to time in accordance with the nature of the war news.

Gas Light & Coke ordinary were higher at 17s. 4½d. In other directions, Amalgamated Metal moved up 10½d. to 16s. 3d. and, awaiting the financial results, Imperial Smelting further improved from 13s. 9d. to 16s. 6d. Fisons ordinary remained firm around 41s. and business at 25s. was recorded in Cooper McDougall. British Plaster Board were 27s. 6d., and Associated Cement 56s. 10½d., while Cellon 5s. shares were around 17s. Shares of companies associated with plastics were more active; British Industrial Plastics 2s. ordinary were better at 4s. 7½d., while Lacrinoid Products were 4s. 3d. and Erinoid 9s. 4½d.

Pending the dividend announcement, Tube Investments have been firm at 90s. 3d.; Stewarts & Lloyds were 49s. 9d., while United Steel improved to 25s. 7½d., although at 30s. 9d. Guest Keen lost part of an earlier improvement. Goodlass Wall 10s. ordinary were better, dealings being recorded up to 12s. 10½d. Elsewhere, William Blythe 3s. shares changed hands up to 7s. 6d. at one time. Nairn & Greenwich held their recent rise to 57s. 6d., and Barry & Staines showed recovery to 36s. 3d. Moreover, Wall Paper Manufacturers deferred units at 30s. 9d. more than held their recent improvement. General Refractories were better at 12s. 10½d.

Textile shares remained active and, like most other securities, were higher on balance, although at the time of writing profit-taking sales have prevented best prices from being maintained. British Celanese were 16s. and the second preference 28s. 6d., sentiment having been assisted by the agreement reached in regard to the scheme for dealing with second preference dividend arrears. Following an earlier advance, Courtaulds eased slightly to 44s. 7½d., Bradford Dyers to 15s. 7½d., and Calico Printers to 13s. Among other securities, United Molasses reacted to 29s. 3d. and were virtually unchanged as compared with a week ago. British Match remained around 36s. 9d. Triplex Glass were moderately better at 30s. 3d., while International Paint moved up to 103s. 9d. Lewis Berger were firm at 61s. 6d., awaiting declaration of the dividend.

British Drug Houses remained at 20s., Sangers at 19s. 10½d., and Timothy Whites were 23s. 3d. Monsanto Chemicals preference were again 22s. 6d., and Greeff-Chemicals 5s. ordinary 5s. 7½d. Among oil shares, best prices were not held, but on balance substantial gains were shown in "Shell," Anglo-Iranian, Burmah Oil, and Anglo-Egyptian Oilfields.

MINISTRY OF SUPPLY

Turn out your NON-FERROUS METALS NOW!

Upon them largely depend the accuracy, deadliness and efficiency of Britain's instruments of war. Practically all of them have to be imported across thousands of miles of dangerous seas, making heavy demands on shipping space.

Make a clean sweep of your unwanted COPPER, ZINC, LEAD, PEWTER, WHITE METAL BRASS AND BRONZE, ALUMINIUM SCRAP

The need for vast and increasing quantities of these metals must be met by a national search for everything made from them which is broken or serving no useful purpose.

WHAT TO SEARCH FOR

Here is a list of some of the important non-ferrous metal articles, parts and equipment likely to be found on your premises. Use it as a guide to your search for everything you can spare.

COPPER — cable, electrical parts and fittings, sheathing, tube, turnings, wire.
ZINC — sheet, cuttings.
LEAD — covered cable, pipe, sheet, solder.
WHITE METAL — anti-friction metal, plumbers' jointings, solder waste.
BRASS — pipe, sheet, tube, turnings.
BRONZE — bearings, bushes, cocks, couplings, crown wheels, junction boxes, unions, valves.
ALUMINIUM SCRAP (and its alloys) — pipe, sheet, castings, tube, turnings.

HOW TO DISPOSE OF IT

1 Sell your non-ferrous scrap to a Merchant.
2 Or hand it in to a Local Authority Depot.
3 SPECIAL COLLECTIONS of amounts over ONE TON may be obtained by getting in touch with the nearest Demolition and Recovery Officer. If you don't know his name, write to The Ministry of Works & Planning, Lambeth Bridge House, London, S.E.1.

NOTE: Under the provisions of the Scrap Metal (No. 2) Order, 1942, if you are in possession of more than 3 tons of Scrap Metal, it is now an offence not to disclose the fact to The Ministry of Works & Planning, Lambeth Bridge House, London, S.E.1.

WANTED! INDUSTRIAL SALVAGE STEWARDS

Salvage is of such great and increasing importance that it should be made the personal responsibility of one particular individual in the various departments of every organisation. Appoint your own Industrial Salvage Stewards. Put them in sole charge of an intensive drive for

STILL MORE PAPER, RUBBER, RAGS, BONES, KITCHEN WASTE—AND METAL

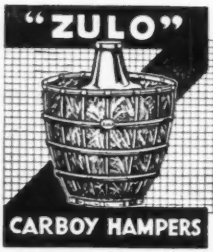
British Chemical Prices

Market Reports

SO far as the movement against contracts is concerned trade conditions in the chemical market continue to be satisfactory with supplies of the leading heavy chemicals in steady call, while a fair volume of new inquiry is reported. The price position throughout the market is steady, quotations in many instances showing a firmer tendency. Among the soda products a continued demand is reported for bicarbonate of soda, Glauber salt and salt cake, with inquiries for acetate of soda and nitrate of soda well maintained. The limited quantities of bichromate of soda are being distributed on a quota basis. In the potash section a well sold position is reported for permanganate of potash, with bichromate of potash and caustic potash in good request. Yellow prussiate of potash continues scarce and values are largely nominal. In other directions the demand for formaldehyde is well maintained, while an active trade is passing in arsenic. There is no change to report in the acid section. In the coal-tar products section there is a continued good demand for cresylic acid and in other directions the demand is steady. Business in the naphthas is somewhat hesitant, as the trade is awaiting the publication of the control order.

MANCHESTER.—Values have fully maintained their firmness throughout the range of heavy chemical products on the Manchester market and the undertone is undoubtedly strong, though there has been no further actual movement of any consequence. The demand for sulphuric and hydrochloric acids is maintained, and most of the soda compounds are moving steadily into consumption. The potash chemicals generally are in short supply and not easily obtainable. In the by-products market a limited amount of export business in pitch is reported at around 55s. f.o.b., while most other classes of material, including the xylols and naphthas are in steady demand.

GLASGOW.—There is no change in the position in the Scottish heavy chemical trade during the past week. Home business remains steady. Export inquiries are rather limited. Prices remain very firm.



LEIGH & SONS METAL WORKS
Orlando St.
BOLTON.

WELFARE SUPERVISOR
of Large Firm writes
"I should also like to mention the value of your various products in preventing
DERMATITIS
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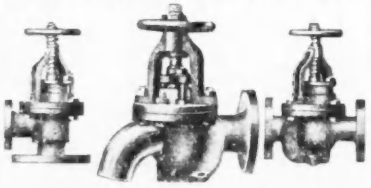
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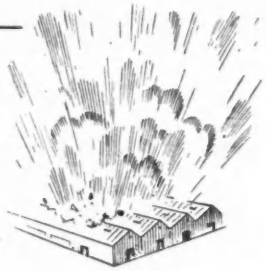

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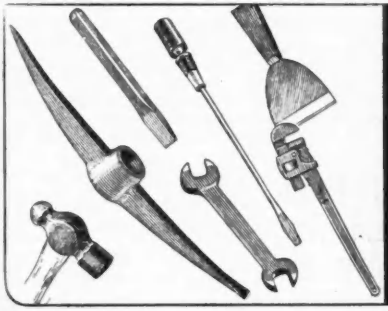

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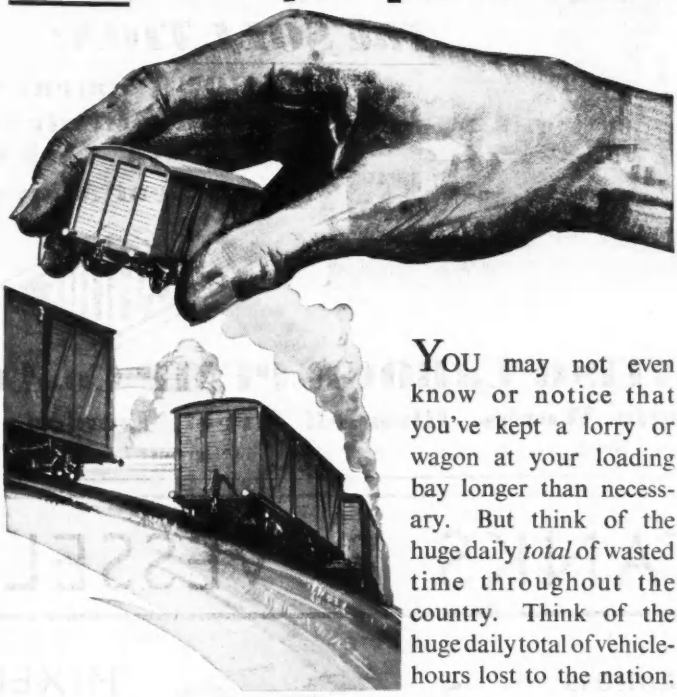

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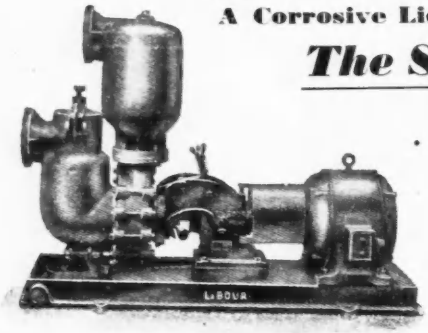

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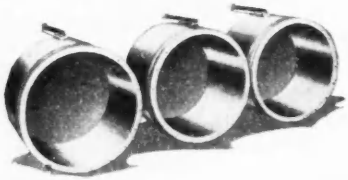

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Organising Research

THE subject of research is inevitably of extreme interest to scientific men of every class. There is much mental contentment to be gained through the application of knowledge to practical ends. But in the discovery of new knowledge, or in the discovery of how existing knowledge may be put to practical effect, lies the most interesting and stimulating application of science. The great speed of world development—whether that speed be good or bad we will not here argue—has been due to the application of research. Some 30 or 40 years generally elapse between the discovery of an important new principle in pure science and its extensive application to practical ends. With the more intense devotion of all civilised nations to research, that interval is likely to be shorter in the future. In time of war, the application of science to practice should be very rapid; for it is that rapidity which wins wars. All will remember how quickly the magnetic mine was countered. In time of peace, the economic prosperity of nations may well depend upon the same factor.

During the course of this year, a famous scientific man delivered certain addresses bearing on the best use of research. So far as we are aware no printed record exists of his words; but some of his ideas seem peculiarly apposite to this central problem of how to make research "pay." What exactly do we mean by "pay," when applied to research? The industrialist no doubt means that the research department shall pay dividends by making important discoveries that can be turned into money. That is presumably why he keeps the department in being. That attitude, we submit, is utterly wrong. No one can produce ideas from a vacuum—whether that vacuum exists in nature or in his brain, or by reason of his complete insulation from his surroundings. New ideas, brilliant imaginative efforts as they often appear to be, always arise from contact with others; from some chance remark in a discussion; from some new idea in a paper. The mind is stimulated by something, and without that stimulus it cannot function. The mind must be fertilised just as the plant must be fertilised. The research worker's mind should be open to fertilisation through (a) his own wide knowledge of the subject, (b) his contact with the practical problems he is setting out to solve, and (c) his contact

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with the world in general. One of the major problems of any research institute or laboratory is how that "fertilisableness" (if we may coin a word) can be secured. To answer our question before pursuing this interesting by-path, research "pays" when it produces (a) new results of value, (b) a new application of old results, or (c) a habit of mind in the practical men that is to the general advantage of the employer—whether this last is an individual, a firm, an industry, or a whole nation.

The research worker, we have said, requires a wide knowledge. He requires, more than that, a receptive mind. Those who have read Bernard Shaw's *Major Barbara* will remember the difficulty of the millionaire looking for his successor: "If he (*i.e.*, any boy) shows the least ability, he is fastened on by schoolmasters; trained to win scholarships like a racehorse; crammed with second-hand ideas; drilled and disciplined in docility and what they call good taste; and lamed for life so that he is fit for nothing but teaching." Is not this peculiarly true? If true, is it not a warning that in our post-war educational system we must avoid making scholarship examinations the path to the Universities?

It is a curious fact, that in this country scientific men are almost wholly drawn from the secondary schools; comparatively few come from the public schools. The reason is probably the lack of interest in public schools in scientific subjects and their over-insistence on Greek and Latin and the classics in general. We are all in favour of scientists-to-be having a grounding in the classics; but it can be overdone. The ideal is surely a balanced education. The scientific men of some nations seem to thrive on intensive cramming of scientific knowledge. In general the students of this country and America do not attain so high an academic standard. They retain, however, a freshness of outlook, and a faculty of going to the roots of the problem which perhaps belongs to their more practical upbringing. The ideal scientific research man should have a good knowledge of his subject—though much of the knowledge imparted in an honours course is often wasted unless the student proposes to teach—but above all he should have a practical knowledge of affairs; he should mix with his fellows; he should have other interests outside his research work; he should have a practical knowledge of the industry for which he works if he is in an industrial research laboratory.

What is the best method of conducting industrial research? Since the average Britisher is an individualist, the reader may well ask if there is a "best" way. Probably there is not, but there are certain guiding principles. The first is that the research laboratory must not be isolated. Payment by results, or (what comes to the same thing) a constant asking why results are not forthcoming, will lead quickly to sterility. It can be taken for granted that the research worker is keen on his job; if he were not he would not be a research man. He is therefore pursuing knowledge for its own sake, and is just as keen as his employer to get results. It is therefore a good thing for a research man not to be wholly engaged in research. There are times when research seems like a mouthful of sawdust; when even the research man has his keenness temporarily sapped by disappointment; when a feeling of frustration comes uppermost. In such circumstances it is good if he has an alternative job, such as lecturing to students, analytical work for his firm, or something of a more practical nature. From these he will derive fresh ideas; by these contacts he will avoid a vacuum.

There is much to be said for the view that research men should not wholly, or even mainly, concentrate on research. It has been suggested that research associations should be so organised that any scientific man who gets a useful idea should be able to work it out in the laboratories of the association and, having done so, return to his employment. A constant flow of new men, with fresh ideas, will prevent that insulation which leads to sterilisation. This method has been used at certain universities with good results, and could be extended. We should not organise research on mass production principles, but it is hardly likely that the present organisation is the best possible. Only very few research men of a high order are produced each year—one per million of the population seems to be the ratio of frequency—and we must make the best of them.

NOTES AND COMMENTS

Organising Industry

EVOLUTION, not revolution, has been the keynote of progress in Britain throughout the greater part of its industrial history, and it is evidently with this idea in mind that a group of distinguished industrialists has produced a statement entitled "A National Policy for Industry." This is designed to obviate any gross dislocation of industry, and all that that implies, during the transition period which must follow this war, and it is noteworthy that due recognition is given to the social obligations of Industry. Particulars are given of plans for closer contact between works councils and management, and between Trade Unions and management; it is suggested that the Unions might go further into schemes for closer co-ordination among themselves. A full list of the duties which industry owes to its employees is detailed—and the term "duties" is interpreted in its widest sense—opportunity of rising to positions of highest responsibility must be afforded to all; subsistence allowance for unemployment must be regarded as a right, not as a charity. Family allowances, education, and housing are all considered not simply as a matter "for the Government," but as part of the duty which Industry owes as a recompense for its continued prosperity.

A Central Council

THE main theme of the publication is, however, an appeal for the closer organisation of Industry, not under State (*i.e.*, Civil Service) management, but under Trade Associations, which would promote collaboration both within each section of industry and with other branches of trade, and at the same time make a clear distinction between useful and wasteful competition. Over all would be an elected Central Council, representative of the whole of industry, and acting in the capacity of adviser and referee. As a final Court of Appeal an Industrial Tribunal would be set up, not by industry itself, but by the Government. While, of course, our first task after the war must be to set our own house in order, the need to study international problems will be almost equally immediate. Our relations with the Empire, and with the United States, Russia, China, and our other friends are of primary importance, and this side of the question has not been forgotten in the industrialists' statement. Among the functions of the Central Council of Industry would be the task of acting on behalf of British industry in furthering international economic co-operation.

Production-Planning

REFERENCE may here be made to an address given this week by Mr. T. W. Fairhurst to the Institute of Export, entitled "The Sins of the Export Fathers." Speaking with almost brutal frankness, Mr. Fairhurst criticised our somewhat primitive methods of planning production, which, he claimed, had resulted in the underselling of certain of our products by those of another country which enjoyed a higher standard of living, and that in face of a tariff bar. It is obvious that the establishment of Trade Associations with a wide scope and empowered to arrange the pooling of information would facilitate better production-planning. There is a long road to travel before this end is gained, but constructive good-will, plus a keen look-out for backsliders, will go far towards its attainment.

Science for Victory

WITH the above title as its text, the conference of the Association of Scientific Workers, held at Cardiff in October, reached a number of conclusions which amount in great part to what this journal has been attempting to affirm, in a quiet way, for some time past. What came out of the conference was, in effect, that the scientist should take a more prominent part in the conduct of the war (and of government in general), but that, in order to achieve this, it was necessary for him to get into closer contact with the man in the street. We are never tired of pointing out that the average scientist is too apt to conclude that the layman has some idea of what he (the scientist) is talking about—which is rarely the case—while at the same time he makes an insufficient effort to put his scientific findings into language that the ordinary man can understand. In short, as in so many other branches of human activity, there are faults on both sides. It has been said

—indeed, we have said it ourselves—that the scientist is too absorbed to think about "putting his science across"; but this is, at the best, a poor excuse, and a much larger number of scientific workers should follow the example of a few of their wiser brethren, and put their ideas into simple and interesting language.

Extending the Field

WHEN it comes to considering the question of how scientists are to play a larger part in the conduct of the war and of government in general, there are many points at issue. If they are to deserve such a responsibility, scientists must come out of the laboratory atmosphere—they must, as Dr. Riley said, not await problems, but anticipate them. In the face of the mighty forces of nature, a scientific worker is apt to be modest as to his own capabilities, but he should not confuse this laudable modesty with an unwillingness to take the lead among his fellow-mortals to which his scientific knowledge entitles him. It must be admitted that every obstacle is thrown in his way. For instance, Mrs. Clarke's comparison of the salaries offered to scientists and to plan operators is illuminating. Such organisations, however, as the A.S.W. and the B.A.C. make it their business to look after such matters and the state of affairs is undoubtedly improving. Another shackle that ties the hands of research workers, as Mr. Swann pointed out, is the "trade secret." If science is to benefit mankind to the full, there must be a pooling of information. It is worthy of note that the tobacco industry, in order to save transport, has taken the step of revealing some, at any rate, of its trade secrets among competitors. This is a great step forward; are the scientific industries to lag behind in the march towards better conditions for all?

Chemistry in Court

AN interesting footnote to a *Times* law report is to be seen in the exhibition of "Photography in Science and Industry" at the rooms of the Royal Photographic Society, Princes Gate, London. On March 13, 1942, *The Times* recorded a decision in the High Court to admit to probate a will which had been left, brittle, blackened, and charred, in the safe of a solicitor, after his premises had been burnt out as a result of enemy action in December, 1940. In the exhibition is a photographic copy with the writing clearly visible. The President of the Court said of this, that it was a most astonishing achievement and that, as far as he could see, the whole thing was decipherable. Yet the original showed no visible image by normal photography. The photograph on view was obtained by the silver nitrate method of Superintendent Cherrill, the transient effect being produced by photographing the document while it was in the solution.

Instructional Films

THE exhibition has many items of interest to the industrial chemist, from the photomicrographs showing the properties of various liquid crystals to the 16-mm. instructional films. The cine films include such subjects as ammonia production and the Kallodent process and it is stated that while they are not examples of photography used for the solution of chemical problems, they are included as examples of the use of film in chemical instruction. A section of the exhibition is devoted to photography applied to metallurgy while, among the interesting new photographic materials which have made progress in the various fields possible, is Ilford's Kryptoscreen Paper. This is dealt with more fully elsewhere in this issue.

Education for Industry

EDUCATION in the past has been too often a matter for the individual choice of parents. The result was that industry absorbed a large number of young people with qualifications good in themselves, but wasted in the calling into which they were forced by economic necessity. The industrialists were partly to blame. They took too little interest in the material from which they must draw their personnel until it was too late to ensure that the finished product was the best for their purpose. There is much evidence that a rapid change is taking place in the outlook of industry in this important respect. We have drawn attention in these columns to an increasing interest on the part of industrialists in the education of chemists and scientists. Now, from the other side, so to speak, comes the voice of the National Association of Head Teachers which states, in a memorandum, that the closest co-operation between education, industry, and commerce should be not only encouraged, but secured by legislation if necessary.

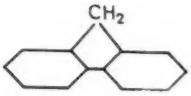
The Coloured Hydrocarbons

Polyenes and Cumulenes

by G. S. RANSHAW

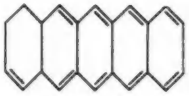
OF over 300,000 known organic compounds, the majority are white or colourless. It was natural to think, therefore, that the type of anomaly which constituted *colour* was linked up with the existence of particular groups of atoms, and numerous theories have been advanced to explain the phenomenon. The theory which has been applied for a long time with the greatest success was the theory of "chromophores" due to O. N. Witt (*Berichte*, 1876, *9*, 522; 1888, *21*, 325). He presumed that the colour of a molecule was due to the existence of a particular group of atoms which he termed a "chromophore." The azoic, thiazinic, and azinic groups were, for example, chromophores. The molecule thus formed, the "chromogen," became according to Witt, a colour, *i.e.*, a compound capable of dyeing or staining, thanks to the introduction of "auxochrome" groups such as NH_2, OH, COOH, and SO_3H, which were capable of salt formation. They had a further effect on the colour in that they were able to displace it either towards the orange or the green. In this form the theory of Witt, revised and extended by various authors, is open to several criticisms: nevertheless, it had a fruitful influence on the development of dyestuff chemistry, while none of the alternative theories proposed appears to lead to new extensions of our knowledge.

One objection to Witt's theory is its implication that compounds containing carbon and hydrogen only, *i.e.*, the hydrocarbons, cannot be coloured. The idea was admissible when the theory was proposed (1876), although a coloured hydrocarbon, carotene, pigment of the carrot, had been analysed by Zeise (*Ann. Chim.*, 1873, *62*, 380) in 1873, his analysis being confirmed in 1887 by Arnauld. Other coloured hydrocarbons had also been described, such as chrysogene by Fritsche (*Compt. Rend.*, 1862, *54*, 910) and acenaphthylene by Behr and Van Dorp (*Berichte*, 1873, *6*, 753), but were voluntarily ignored. About 1875, De la Harpe and Van Dorp (*Ber.*, 1875, *8*, 1048) obtained a red hydrocarbon by oxidising fluorene: this was studied carefully by De Mantz, who recognised that its colour could not be attributed to any impurity. Craebe showed ultimately (*Ber.*, 1892, *25*, 3146) that this hydrocarbon was diphenylene-methane:—

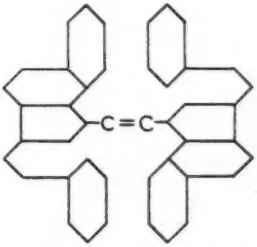


In the end the possibility of the existence of coloured hydrocarbons has to be admitted. This was confirmed by the preparation of several new series of these compounds, notably by Thiele, Staudinger, and Courtot. Thus, in addition to the red and yellow hydrocarbons already known, a green and a blue were prepared:—

Pentacene Blue



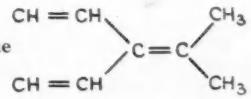
Dibinaphthalene-ethane Green



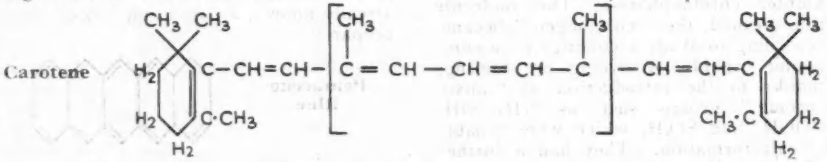
The function of the numerous double bonds in these hydrocarbons is essential, since saturation causes the colour to disappear. However, it is not only the number of the double bonds, but also their disposition which must be considered, since *p*-xylene, for instance, is colourless, while its isomer, dimethylfulvene, is coloured:—

***p*-Xylene**

Dimethylfulvene

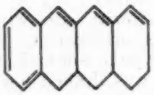


It was easily recognised that the most favourable arrangement of the double bonds was that termed the conjugated system: $-C=C-C=C-$. Several workers studied systematically the influence of an increase in the number of conjugated double bonds. W. Koenigs (*Ber.*, 1925, *58*, 2559) studied the question from the point of view of the triphenylmethane colours and the cyanines, while R. Kühn (*Helv. Chim. Acta.*, 1928, *11*, 87) worked on the hydrocarbons. He succeeded in preparing the homologues of stilbene up to diphenylhexadecaoctene, which possesses eight conjugated double bonds: $C_6H_5-(CH=CH)_8-C_6H_5$. It is a red substance of great stability, and it is noteworthy that these bodies are closely related to the carotene type of colouring matter in plants. Thus, carotene, whose constitution was established by Kühn, Karrer and collaborators, has the following formula:—



The diphenylpolyenes of Kühn doubtless owe their stability to their terminal phenyl groups. At the beginning of 1938 the same worker (*Ber.*, 1938, *71*, 442) succeeded in preparing purely aliphatic polyenes. The highest member of the series obtained was dimethyl-1,12-dodecahexene, crystallising in lemon-yellow needles sublimating *in vacuo* at 160-180/10^{-3} mm. This was the first coloured aliphatic hydrocarbon known. It possesses six conjugated double bonds, while colour first appears at the diphenylenes which have only three double bonds in the chain.

The coloured hydrocarbons of which we have just spoken have their double bonds at least partially in a chain, but a large number of purely cyclic coloured hydrocarbons are now known. It is to this group that the curious "rubenes" of Moureau and Dufraisse (*Bull. Soc.*, 1936, (5) *3*, 1847) belong. These are strongly coloured products whose constitution was discovered only about six years ago. They are considered to be derivatives of naphthacene, itself an orange-coloured hydrocarbon with a curious history. Under the name of "chrysogene," Fritsche in 1862 separated an orange hydrocarbon from oil-tar anthracene. In 1898 Gabriel and Leupold (*Ber.*, 1898, *31*, 1159), transformed ethanediphthalyl into a coloured isomer, naphthacene:—



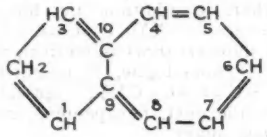
Naphthacene

They showed that it was benzo-2,3-anthracene (2,3-benzanthrene) and gave it the name naphthacene. In 1900, Klaudy and Fink were able to collect, in plant used for cracking Russian petroleum, orange crystals of a hydrocarbon which they designated "crackene." It was only in 1906 that Bernstein (*Ber.*, 1906, *39*, 1238) published the statement that "crackene" and chrysogene were identical. Identity of naphthacene and chrysogene was not established until 1925 by Capper and Marsh (*J. Chem. Soc.*, 1926, 724), and identity of "crackene" and naphthacene not until 1934 by Winterstein and Schön (*Naturwiss.*, 1938, *22*, 237).

Besides colour, the numerous naphthacenes of Dufraisse have the interesting property of reversibly absorbing atmospheric oxygen in the presence of light. This property is also associated with the pigments of plants and of hæmoglobin, whose structure is totally different.

Another group of coloured hydrocarbons has been the subject of work of great interest recently. These are blue, violet, or green liquids of formula $C_{15}H_{18}$ called azulenes, found in certain essential oils, or forming part of them, for example, by pyrogenation with sulphur or selenium. These curious compounds have been known since 1864, but serious difficulties prevented their constitution from being determined until in 1936 Pfau and Plattner succeeded in giving them acceptable formulæ and effected the synthesis of several. They showed that the product obtained from essence of vetiver is a derivative of *cyclo*pentano-*cyclo*-

heptane. Thus, vetivazulene, which has been synthesised, is a violet hydrocarbon identical with isopropyl-2-dimethyl-4,8-azulene, the azulene being the fundamental unsaturated hydrocarbon :—



It is a curious fact that the fundamental hydrocarbon from which these azulenes are derived, *cyclo*pentano*cyclo*heptatriene, is isomeric with naphthalene, but while this is colourless, azulene is blue. It may be asked : whence comes the difference? It is known that the pentadiene ring is more chromophoric than the benzene, since it is the basic structure of the fulvenes. Beyond this, if *cyclo*heptatriene is not known, apparently, it should be remembered that *cyclo*octatetraene is yellow. The formula proposed for the azulenes is, therefore, not in contradiction with previous knowledge.

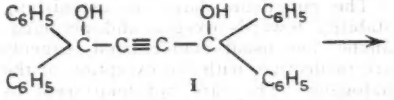
In all these compounds the existence of conjugated double bonds is readily recognised. What would happen with a hydrocarbon in which the double bonds were no longer conjugated, but contiguous? The type of hydrocarbon visualised is represented by allene (propadiene), $CH_2 = C = CH_2$, but up to now ony a few compounds are known whose contiguous double bonds number more than two. The preparation of such compounds was described by Kühn and Wallenfels (*Ber.* 1938, *71*, 783). They proposed the name "cumulenes" for them. The method of synthesis employed is modelled on that used for preparing the polyenes. This consists in treating an ethylene glycol with phosphorus iodide. If one starts with a 1,2-glycol, the diiodide is an intermediate product which spontaneously loses I_2 to furnish polyene :—

$$R.CH=CH-CHOH.CHOH.CH=CH-R \rightarrow R.CH=CH-CH=CH-CH=CHR.$$

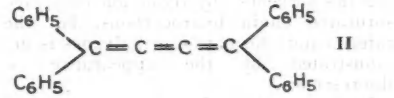
Now Kühn considered that the same reagent P_2I_4 would react with other glycols to give polyenes also :—

$$R.CH=CH.CH-CH=CH-CH-CH=CHR \rightarrow \underset{I}{\quad} \quad \underset{I}{\quad} \quad R-(CH=CH)_4R.$$

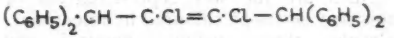
Kühn had then the idea of applying this method to the acetylene glycols. He used in the first place tetraphenylbutindiol (I) and perceived that the glycol treated with P_2I_4 furnished a hydrocarbon identical with tetraphenylbutatriene (II) already obtained by Brandt in 1921 starting with *symm.*-tetraphenyldichlorobutene (III). The constitution of the



I

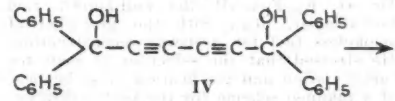


II

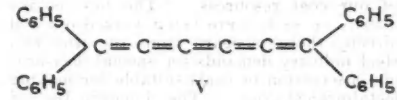


III

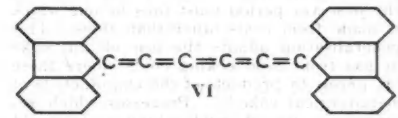
hydrocarbon obtained is in no doubt and is confirmed by study of its physical properties. It is yellow, of a shade almost identical with that of tetraphenyloctatetraene, a polyene with four conjugated double bonds in the chain. This fact is general, and the colour of a cumulene is related to that of the polyene possessing one more double bond. Kühn has



IV



V



VI

subsequently prepared tetraphenylhexapentene (V) starting with tetraphenyl-1,1,6,6-hexadiene-2,4-diol-6,6 (IV), itself obtained by condensing benzophenone with magnesium diacetylene dibromide, $BrMg-C\equiv C-C\equiv C-MgBr$. The hydrocarbon $C_{30}H_{20}$ which results from the action of P_2I_4 on this glycol is a scarlet-red colour. By replacing benzophenone with fluorene he obtained di*bi*phenylene-hexapentene (VI) which is violet—almost

black with a greenish tinge when solid. Its solutions are violet like those of permanganate. While this method of preparation gave only 0.3 per cent. of the theoretical yield, Kühn has more recently been able to raise this to 93 per cent. for the tetraphenylhexapentene and to 89 per cent. for the di*bi*phenylhexapentene (*Ber.*, 1938, *71*, 1510).

The cumulenes have an astonishing stability towards oxygen and permanganate. The usual double bond reagents are ineffective, with the exception of the halogens. They are not fluorescent as are the polyenes; by reduction they give saturated chain hydrocarbons, but the intermediate formation of polyenes is demonstrated by the appearance of fluorescence.

Such are the sole representatives of this new series of coloured hydrocarbons. Besides their curious chemical and physical properties, these compounds are of great interest from the stereochemical point of view. Van 't Hoff (*La Chimie dans l'Espace*, 3rd Ed., 1908, Hermann) has in effect established that an allene, XY–C=C=CXY, may show optical isomerism. Such compounds have been dealt with by Mills and Maitland (*J. Chem. Soc.*, 1938, 987). The theory predicts that, in addition, the homologue butatriene, XY–C=C=C=C–XY, should show *cis-trans* isomerism, the following homologue, pentatetraene, XY–C=C=C=C=CXY, optical isomerism, the next, hexapentene, *cis-trans* isomerism again.

In spite of the efforts of several scientists (Deinroth and Feuchter, Lapworth and Wechsler; *Ber.*, 1903, *36*, 2238; *J. Chem. Soc.*, 1910, *97*, 38) it has not yet been possible to prepare such compounds, so that whether or no the theories of Lebel and Van 't Hoff are correct cannot be proved. Indications from France in the early days of the war implied that the gap was about to be filled, but as to subsequent progress, if any, we are in the dark.

Metallurgical Coke

Plan for Conserving Supplies : Use of Smokeless Fuel

IN a paper presented to members of the Institute of Fuel on November 12, 1942, Dr. G. E. Foxwell, the well-known fuel technologist, dealt with the provision of smokeless fuel for post-war reconstruction. He stressed that the selection of coals for carbonisation and gasification must be part of a planned scheme for the best utilisation of our coal resources. "The best coking coals," he said, "are being worked out and already there is heard from the iron and steel industry demands for special measures of conservation of coals suitable for making metallurgical coke. The domestic fuel of the post-war period must thus be one which is made from coals other than these. This generalisation admits the use of nut coke or gas from good coking coals where these are purely by-products of the manufacture of metallurgical coke." Processes which required the use of good coking coals would thus seem to be excluded. This would admit of the use of semi-coke from non-coking or poorly coking coals not of good metallurgical quality and would restrict the carbonisation industry to these coals. Some coals now used for making metallurgical coke were not wholly suited for that purpose and could be reserved for carbonisation for domestic uses. There were existing by-product oven cokes that would be better utilised for domestic purposes than for metallurgical purposes.

Dr. Foxwell puts forward a plea for the unification and rationalisation of the carbonising industry. He believes that adequate quantities of smokeless fuels could be made available by carbonisation for a post-war fuel policy based on smoke abolition if the carbonising industries comprising the gas industry and colliery-owned plants collaborated fully through regional gas grids. As part of a programme for a proposed authority divided into regional boards, Dr. Foxwell suggests an extension jointly by the collieries and the gas industry of the chemical processing of coal (*e.g.*, the Fischer-Tropsch process) and of the by-products of carbonisation, together with an extension of the chemical manufacturing side of the industries. The new organisation, he concludes, would thus become a coal processing industry in a very real sense.

I.G. has patented (Ger.P. 699,961) an improvement in the process for recovering copper from waste waters in the rayon industry. Under the process, the alkaline solution of the precipitating bath and an acid decoppering liquid are mixed in such proportions as to give a *p*H 6-8, generally varying between 6.5 and 7.5. The mixture is immediately passed through a sand filter and the copper is recovered in the form of $Cu(OH)_2$ from the sand for re-use in the usual way.

Heavy Chemicals in Russia*

Low-Temperature Research

by M. RUHEMANN, Ph.D.

THE building up of a heavy chemical industry from scratch under conditions of socialism in a country with vast natural resources covering one-sixth of the earth's surface has made the Soviet Union, during the last fifteen years, one huge field of applied thermodynamics. Low-temperature research and development formed an integral part of the Five-Year Plans for the industrialisation of the country, its principal object being the rational and economic utilisation of the Soviet Union's gas resources. This involves the separation of natural and industrial gaseous mixtures, resulting in pure useful gases and in mixtures of a well-defined composition suitable for various industrial processes. Since all substances are completely miscible in the gas phase, the separation of gaseous mixtures necessitates the introduction of other phases that are not gaseous, and the most economical way of producing such phases is by liquefying at least a part of the initial mixtures. Since the critical temperatures of most of the components of gaseous mixtures lie below ambient temperatures, this liquefaction has to be carried out at low temperatures, thus requiring a specialised technique and refrigerating machinery.

The U.S.S.R. has very large natural gas wells as well as gas resources associated with mineral oils. Apart from methane as the main constituent, these gases contain varying amounts of ethane, propane and butane. Some of them, especially those heavily diluted with nitrogen, contain appreciable traces of helium.

Cracking and Hydrogenation

The cracking of mineral oils and the hydrogenation of oil and coal yields annually billions of cubic feet of gas containing light paraffins and olefins as well as hydrogen. Of these the most important constituent is ethylene, which forms the basis for a number of chemical processes, notably for the manufacture of artificial rubber. Still greater quantities of coke-oven gas, a by-product of the metallurgical industries and containing mainly hydrogen, methane and carbon monoxide, but also several per cent. of ethylene, are produced in many parts of the U.S.S.R., only a relatively small portion being required to fire the coke ovens themselves.

Add to these gases atmospheric air as a source of oxygen, nitrogen, and the rare gases and we can form an idea of the scope and possibilities opened up to scientists and engineers with no vested interests and obsolescent plant to consider, and with the financial backing of an all-embracing State organisation. To sum up, the principal industrial products to be derived from low temperature gas separation are as follows:

From Air.

Oxygen for oxy-acetylene cutting and welding; "rich air," containing anything between 25 and 60 per cent. oxygen, for blast furnaces and gasification of coal, especially underground gasification;

Nitrogen for synthetic ammonia, and hence for fertilisers and explosives;

Argan, krypton, and xenon for incandescent lamps and discharge lamps.

From Coke-Oven Gas.

Hydrogen for hydrogenation and for the synthetic ammonia industry.

From Cracker Gases.

Ethylene for chemical synthesis, especially for the synthetic rubber industry.

Many secondary products can also be obtained in these processes, such as helium, methane, propane and butane, propylene, butenes, benzene, toluene, xylenes, etc.

Organisation of Resources

The successful utilisation and co-ordination of existing resources required the closest co-operation of economists, scientists and engineers, which presupposes suitable organisation. During the period from about 1930 to 1938, the whole field was organised by the People's Commissariat of Heavy Industry. This comprised several "sectors" or "Glavs" responsible for various fields of industry. Each of these Glavs controlled State Trusts which dealt with the actual production of plant and products, and which themselves controlled numerous works and factories. The Commissariat as a whole, as well as every Glav and Trust and almost every factory, directed research institutions and laboratories with varying degrees of specialisation. An important feature of this system of organisation was the State Designing Institute or *Gipro*, as it is called, attached to each Glav. These institutes, employing mainly engineers and draughtsmen, formed a valuable link between the research scientists and engineers and the actual production process.

Thus, to take an example, research connected with the synthetic ammonia industry was conducted, on the synthesis side, by the State Nitrogen Institute of the Nitrogen

* From an article in *Science and Technology in the Soviet Union* (Pilot Press, London, 2s.), a collection of articles based on the symposium of papers presented at Easter, 1942, under the auspices of the Faculty of Science, Marx House.

Trust of Moscow and, on the low-temperature side, for the production of hydrogen and nitrogen for synthesis, by the Physico-Technical Institute of the Commissariat of Heavy Industry and its Low-Temperature Research Station at Kharkov. The designing of the plant was in the hands of Giproazot and Giproazot Mash, and the plant was actually built by the works of the Commissariat of Heavy Industry, notably the copper works at Tambov and the compressor works at Moscow and Sumi.

Liquid-Gas Equilibria

The industrial separation of gases at low temperatures requires an intimate knowledge of the thermodynamic properties of the components of gaseous mixtures and their liquid-vapour equilibrium. The questions arising are, briefly, of the following nature:

(a) How much heat must be withdrawn from a mixture in order to liquefy it? (implying a knowledge of heat capacities and latent heats of mixtures).

(b) By what means can this heat be withdrawn? (involving questions of refrigeration by compression and expansion of gases and liquids and therefore the thermodynamic functions of gaseous refrigerants).

(c) How can this heat be transferred through the plant? (requiring data on heat transfer coefficients, film coefficients and viscosity).

(d) What are the compositions of the liquid and gaseous fractions obtained at various pressures and temperatures? (involving much detailed research on phase-equilibrium at low temperatures).

Ten years ago few of these questions could be answered, even for special cases. The data were either not known or unpublished. For want of information, there could be no question at all of a general theory. Now, mainly as a result of efforts of Soviet scientists, we possess a wealth of extremely valuable data on gases and gaseous mixtures and their equilibria with liquids. Not only can existing industrial problems be solved, but, in the course of the last two years, Soviet scientists have for the first time caught up with engineering and industry in the sense that they have data available for the next steps in industrial development. To one who has followed up this race between scientific research and industrial development in the U.S.S.R. for some years, and has had occasion to realise the enormous demands put on scientists from the practical side by the veritable breakneck speed at which industry advanced, presenting ever new problems for the scientists to solve, this is indeed a notable achievement.

Research in connection with the separation of gases is best illustrated with the help of one specific example, in this instance the separation of coke-oven gas for the production of a 3 : 1 mixture of hydrogen and nitrogen for ammonia synthesis, one of the earliest schemes of Soviet industrialisation, which has in fact formed the basis of the whole of Soviet Low-Temperature Construction up to the present day.

In 1931 the U.S.S.R. received from a German firm the largest coke-oven gas separating unit ever built, an aggregate for rather over one million cubic feet of coke-oven gas per hour. At that time the U.S.S.R. knew nothing about gas separation. At the same time the above-mentioned organisation called Giproazot was formed and the Kharkov Institute was asked to supply data for designing Soviet separating plant. By 1933 the German plant was running smoothly and the data were beginning to come in. By 1935 the first Soviet plant was designed and at the makers. By 1937 it was running and by 1938 there were at least three more plants of various kinds in the U.S.S.R. supplying mixtures of hydrogen and nitrogen to the ammonia industry. To-day, there is hardly a single problem connected with coke-oven gas that we have not the data to solve.

Gas Separation Process

The production of hydrogen and nitrogen from coke-oven gas involves cooling the initial gas in stages, condensing out one component after another, until finally only hydrogen and nitrogen remain. The refrigerant used is liquid nitrogen from a separate air-separating plant, which simultaneously brings the composition up to the stoichiometric figure. In the course of this process four main liquid fractions are formed and re-evaporated, the ethylene fraction containing ethylene, ethane, and methane, the methane fraction containing mainly methane, nitrogen, and carbon monoxide, and the CO fraction containing mainly carbon monoxide and nitrogen. The gases in contact with these fractions contain almost all the hydrogen, but some hydrogen dissolves in the liquid. Thus the main necessity was to know the composition of all these fractions as a function of temperature and pressure, and incidentally to ascertain how much hydrogen is lost by solution.

With this in view, the following gas-liquid equilibria have been extensively studied at the Kharkov Low-Temperature Research Station and some other laboratories:—

Ethylene-methane and ethylene-ethane.

Methane-nitrogen and methane-carbon monoxide.

Ternary mixtures of hydrogen, nitrogen, and methane.

Ternary mixtures of hydrogen, nitrogen, and carbon monoxide.

Valuable papers on these systems have

been published which have incidentally given most useful demonstrations of so-called regular and perfect solutions, as well as some that were neither regular nor perfect, and which can now be used as a basis for all industrial processes involving these mixtures.

The final step in the separation of coke-oven gas consists in scrubbing the carbon monoxide out with liquid nitrogen. This must be done very thoroughly as the presence of even small traces of carbon monoxide in the product poisons the catalysts in the subsequent synthesis of ammonia. A particular study of the theory and practice of scrubbing was therefore made at the Low-Temperature Research Station, which has since been followed up by other work in other laboratories.

The use of liquid nitrogen as the main refrigerant in this process led to the study of the thermodynamic properties of nitrogen, as the result of which a new thermodynamic diagram of nitrogen was constructed, which is now in general use in America.

Study of Benzol

A difficulty encountered in the separation of coke-oven gas consists in the solidification of benzol, which is present in larger or smaller amounts in the initial gas, depending on the efficiency of the debenzoling plant at the coke oven. The benzol fraction contains benzene, toluene, *m*-xylene, small traces of the other two xylenes and a residue of naphthalene. Technically the problem arises in the following form: "What compositions of the benzol fraction are permissible if the fraction is to be cooled to −45° C. without solidification." A number of binary and ternary systems containing these components were investigated at the Research Station and the solidification curves determined. The principal ones were benzene-toluene-*m*-xylene and benzene-*m*-xylene-naphthalene. The eutectic lines were fixed and a solid model made of the ternary systems. B. M. Kravchenko has published an account of a first attack on the quaternary systems and it is to be hoped that, when he is able to take up this work again, a valuable contribution to this extremely difficult problem will result.

The flow of liquids and gases in the intricate pipes involved cannot be accurately gauged without a knowledge of the viscosities of the liquefied gases and their mixtures. Only some six years ago nothing at all was known of the viscosities of liquefied gases. Soviet scientists have now determined them, not only for most pure liquids at temperatures ranging from the melting point to the critical point, but also for a large number of mixtures, in some of which the relation between viscosity and composition was quite unexpected. The systems investigated are:—

Pure liquefied gases at all temperatures and pressures.

Oxygen, nitrogen, carbon monoxide, methane, ethylene, ethane, propylene.

Binary mixtures.

Ethylene-methane, methane-nitrogen, oxygen-nitrogen, carbon monoxide-nitrogen, propylene-ethane.

It is not merely incidental that these researches, intended primarily to supply data for designing separating plant, have in fact laid the basis for a theory of the liquid state. The scientists engaged in this work had this aim in mind. They consistently refused to treat the problems narrowly, merely determining values needed to meet some specific case. On the contrary, every experiment and every piece of apparatus was designed to furnish as much information as possible concerning the systems investigated and every effort was made to achieve scientific accuracy, whether or not this was required for the specific technical problem.

The experiments here referred to are all connected with what may be termed the "classical" process for separating coke-oven gas, in which the object is to obtain a mixture of hydrogen and nitrogen. But valuable work was also carried out with a view to obtaining other products not envisaged in the original process. Thus it could be shown experimentally, on a semi-technical scale, that it is possible to obtain technical hydrogen from coke-oven gas with a purity of more than 96 per cent. with the help of liquid nitrogen boiling under reduced pressure. Moreover the production of pure ethylene from coke-oven gas was shown to be technically and economically possible, although the ethylene content of the gas is only 3 per cent.

SUNVIC CONTROLS, LTD., 1 Kingsway, London, W.C.2, have issued a new publication VU10 (a) explaining the uses and construction of their "Hotwire" vacuum switches, by means of which some critical event such as the attainment of a prearranged level by fluid in a tank, the starting and stopping of machinery, or of the flow in pipes is made to complete an electric circuit which in its turn operates some controlling mechanism.

In appearance the switch is a sealed tube, not much larger than a wireless valve, but it is capable in various sizes of handling up to 10 kW. at 440 volts. This type of switch is suitable for controlling alternating or direct current; the low, non-inductive load presented by the hot wire winding permits the use of ordinary mains supplies for the control device circuit without danger of arcing at the control contacts. The switch is absolutely silent in action, and can be supplied adjusted for a time delay of up to 30 seconds.

Association of Tar Distillers

Notes of the Month

AT its last meeting the Executive Committee of the Association received reports on recent discussions relating to the nomenclature for tar fuels and arranged for the publication of a nomogram showing the relation between fuels of different viscosity and their atomising temperatures, etc. Arrangements were reported for the carrying out of full-scale tests of roofing material based on pitch, while on the general question of the replacement of imported materials by pitch for building and allied construction, it was noted that the active co-operation of users of imported material was in ample evidence.

The President reported that he had completed visits to the eight regions into which the industry was divided and was now preparing to discuss further with the chairmen of the regions the subject of organisation of the industry which had been the primary topic for examination in his discussions with the separate regions. The Executive Committee agreed that the tar-distilling industry should co-operate on a regional basis with the Association of British Chemical Manufacturers in respect of fuel efficiency and economy, that Association having arranged for district committees working in close co-operation with the Ministry of Fuel and Power. The Committee also agreed that a careful investigation should be made into the depreciation allowance for income tax purposes in respect of plant.

Kryptoscreen

New Fluorescent Paper for Radiography

FOR many years X-ray films and paper have frequently been used in conjunction with a supplementary intensifying screen generally consisting of a layer of calcium tungstate or zinc sulphide which fluoresces under the action of X-rays, emitting light that has a powerful action on the X-ray emulsion. These screens are of great assistance in reducing the time required for the exposure, but they invariably introduce some lack of sharpness into the radiograph. Recently, however, a fluorescent material has been produced in the Ilford laboratories which, while having a considerable intensifying effect, produces no detectable failure in definition. Details of a photographic paper made with this product, which forms part of the exhibition at the Royal Photographic Society, Princes Gate, London, have been given to THE CHEMICAL AGE by the manufacturers.

Ilford "Kryptoscreen" X-ray paper, they say, is a new departure in the field of radiography. Beneath the silver halide emulsion coating is a layer of fine white pigment which fluoresces under the influence of X-rays, emitting a blue-violet light; this, the makers state, achieves the double purpose of shortening exposures and much improving the gradation of radiographs made upon the paper. The search for a fluorescent material which neither lowers the sensitivity of photographic emulsions nor impairs definition and which can be produced at a sufficiently low cost to be used in the above manner has been carried on by the Ilford research laboratories for many years. The definition of radiographs produced by "Kryptoscreen" is, it is claimed, of the highest order and, at the same time, it is but little inferior in speed to ordinary X-ray paper exposed in contact with a high-speed calcium tungstate screen.

Structural Carbon

Alternative Material in Chemical Plant

AS part of the American effort towards the conservation of critical war material, considerable attention is being given to the provision and use of alternative materials for chemical plant. Metals and rubber are affording the main problem at the present moment, and, in an article which covers the whole field of substitute materials, *Chemical and Metallurgical Engineering* calls the attention of its readers to the possibilities of structural carbon, applications of which have developed rapidly in recent years.

Ample raw material is available despite the enormous demand for carbon electrodes. The present chief deterrent to more widespread use of structural carbon lies in the lack of facilities for producing finished materials. Carbon can be obtained in both ordinary and impervious forms, as well as in a porous variety for filtration and bubble-producing applications. It is made in a wide variety of standard shapes, some so large as materially to reduce the construction time of large equipment. Carbon tubes are being used extensively for their high heat-transfer ability in the assembly of heat exchangers. All-carbon centrifugal pumps are being made, together with small vessels, cylindrical tower sections, valve bodies, etc.

Carbon and graphite piping must be handled with a minimum use of high-pressure tools. It is recommended that pipe be handled and tightened by hand or with assistance of a rope wrench. It is a good idea to carry in stock repair couplings and slab material. If a break does occur the broken pieces can be collected, fitted into original position and cemented together, using carbonaceous cements recommended for the purpose. Should the broken pieces be too small to justify this type of repair it can be made by using the slab stock in store. Carbon slabs can easily be shaped to proper dimensions and cemented over the opening in the vessel.

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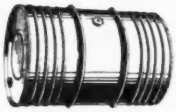

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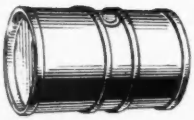

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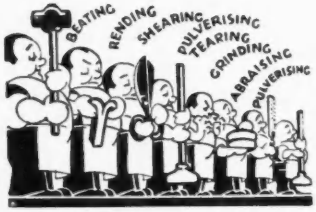

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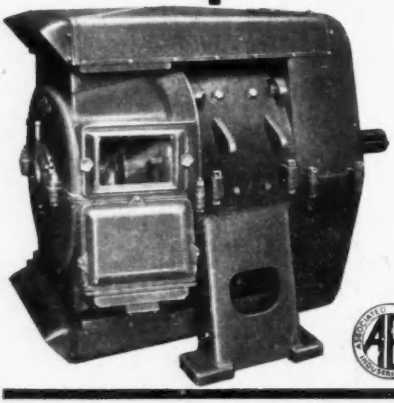

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